Equivalence of space and time.

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Time and space are actually equivalent: when we have at least one dimension of space (and more), we inevitably have time. This strictly follows from Einstein's STR. Let us show the derivation of the equivalence of space and time:

$$\text{time} \equiv \text{length}$$

To do this, let us turn to the interval, namely to the previously established fact that the speed of light cannot be overcome in our Universe [1]:

$$v = (c * L) / (L^2 + S^2)^{0.5}$$

For v^2 we write:

$$v^2 = (c^2 * L^2) / (L^2 + S^2)$$

From the last formula it is clearly seen that the ratio v^2 / c^2 will be equal to:

$$v^2 / c^2 = L^2 / (L^2 + S^2)$$

That is, we got a strict equivalence of time and space (the interval is an analogue of the length between two events in space-time):

$$\text{time} \equiv \text{length}$$

since speed is actually synonymous with the concept of "time".

On the left side of the equation we have a ratio of speeds (ratio of times), and on the right side of the equation we have certain ratios of lengths. Therefore, there is only one conclusion: time and space are equivalent.

Let us demonstrate this equivalence more clearly using Einstein's formula for time:

$$\Delta t = \Delta t0 / (1 - v^2 / c^2)^{0.5}$$

Let's make elementary transformations:

$$\Delta t / \Delta t0 = 1 / (1 - v^2 / c^2)^{0.5}$$

We write the last formula taking into account that:

$$v^2 / c^2 = L^2 / (L^2 + S^2)$$

Then, we get a very clear formula that displays the equivalence of space and time in an explicit form:

$$\Delta t / \Delta t0 = 1 / (1 - L^2 / (L^2 + S^2))^{0.5}$$

Since on the left side of the equation we have certain timing relationships, and on the right side of the equation we have certain length ratios. That is, temporal relationships are absolutely equivalent to spatial relationships.

Naturally, $(1 - v^2 / c^2)^{0.5}$ is completely equivalent to $(1 - L^2 / (L^2 + S^2))^{0.5}$, that is:

$$(1 - v^2 / c^2)^{0.5} = (1 - L^2 / (L^2 + S^2))^{0.5}$$

Taking into account the equivalence of time and space, it becomes obvious that time always arises when we have at least one-dimensional space. For example, let's say we have a fundamental two-dimensional world at the quantum level (x, y) [2].

Due to the equivalence of time and space:

$$\text{time} \equiv \text{length},$$

we inevitably have time, and as a consequence, the Heisenberg uncertainty principle.

$$x, y \equiv x, t \equiv y, t \equiv t, t$$

In fact, we have to admit that there are quantum space-time fluctuations in which time goes into length ($t \rightarrow x$) and length goes into time ($x \rightarrow t$). That is, the dimension of space fluctuates into the dimension of time ($x \rightarrow t$), and vice versa.

This means that from the two-dimensional world (x, y), we automatically receive time, which means a certain internal movement of the two-dimensional world, that is, a three-dimensional space (x, y, z) arises. And since we also have time, a standard 4-dimensional space-time continuum (x, y, z, t) arises.

Given the equivalence of time and space, the quantum fluctuations of the two-dimensional world can be depicted as follows:

$$x, y \equiv x, t \equiv y, t \equiv t, t$$

Moreover, it is very clear in the transition to 4-dimensional space-time:

$$X \equiv Y \equiv Z \equiv T,$$

$$(X, Y, Z, T)$$

Note that the spin of an elementary particle is a certain internal motion of the particle ("quantum motion"). That is, spin, like wave-particle duality, is a consequence of quantum space-time fluctuations.

We especially note that the wave-particle dualism of elementary particles is a direct manifestation of the equivalence of time and space. It is due to the wave-particle duality that elementary particles of the Universe form our space-time continuum.

Confirmation of the above is quantum mechanics. Since it is well known that spin can simultaneously have only two spatial projections: for example, Jx and Jy, or Jz and Jy, or Jz and Jx, which fully confirms the existence of two-dimensional space in the quantum world (x, y), in the world of elementary particles.

But, only one spatial component of the spin (for example, Jz) has a strictly defined value. This is clear, since the other component is time, because when you "fix" one component of space (for example, experimentally), the other will be subject to quantum fluctuations, and therefore will depend on time. This mechanism also explains the "work" of the Heisenberg uncertainty principle.

Here is a quote about spin properties [3]:

"...Unlike the orbital angular momentum, which is generated by the motion of a particle in space, spin is not associated with movement in space.

Spin is an internal, purely quantum characteristic that cannot be explained in the framework of relativistic mechanics.

..."...In particular, it would be completely meaningless to imagine the intrinsic moment of an elementary particle as a result of its rotation "around its own axis"" (Landau L. D., Lifshits E. M. Theoretical Physics. Vol. III, Chapter VIII, § 54 Spin).

Being one of the manifestations of angular momentum, spin in quantum mechanics is described by the vector spin operator... whose component algebra completely coincides with the algebra of orbital angular momentum operators...

However, unlike the orbital angular momentum, the spin operator is not expressed in terms of classical variables, in other words, spin is just a quantum quantity.

The consequence of this is the fact that the spin (and its projection onto any axis) can take not only integer, but also half-integer values (in units of the Dirac constant ħ).

Spin experiences quantum fluctuations. As a result of quantum fluctuations, only one spin component can have a strictly defined value - for example, Jz...

In this case, the components Jx, Jy fluctuate around the average value. The maximum possible value of the Jz component is J.

At the same time, the square J^2 of the entire spin vector is:

$$J^2 = J * (J + 1).$$

In this way,

$$Jx^2 + Jy^2 = J^2 - Jz^2 \geqslant J$$

At J = 1/2, the rms values of all components (Jx^2, Jy^2, Jz^2) are equal to 1/4 due to fluctuations.

...The spin vector changes its direction under the Lorentz transformation. The axis of this rotation is perpendicular to the particle momentum and the relative speed of the reference frames".

I think comments are superfluous...

1. Bezverkhniy V. D., Bezverkhniy V. V. Limiting the Speed of Light, Gravitational Potential, and the Removal and Acceleration of Galaxies in the Universe. SSRN Electronic Journal, March 2021. P. 2. https://dx.doi.org/10.2139/ssrn.3776718, https://vixra.org/pdf/2101.0184v1.pdf
2. Bezverkhniy V. D. How many dimensions is space? ResearchGate, May 2021. http://dx.doi.org/10.13140/RG.2.2.28812.64645
3. Spin (physics). Wikipedia. https://en.wikipedia.org/wiki/Spin_(physics)